CHAPTER 19

PROGRAM OF GEOLOGICAL DISPOSAL OF SPENT FUEL AND RADIOACTIVE WASTES IN SLOVAK REPUBLIC

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19.1 INTRODUCTION

The present stage of spent fuel and high level waste management is a development from the nuclear cycle strategy of the former Czech and Slovak Federal Republic (CSFR). This concept was based on intergovernmental agreements between former CSFR and the Soviet union (USSR) on cooperation and assistance during construction and operation of Czechoslovak nuclear power plants (NPP). The cooperation program between CSFR and USSR provided for confirmed unpaid transport of spent fuel to USSR during the whole time period of operation of Czechoslovak NPP's. Up to 1988, about 700 assemblies of spent fuel were transported to the USSR.

Fulfillment of the above agreements was not fixed in the USSR approach. First, there was a prolonged period of spent fuel storage on CSFR territory, and after the political changes, new transport conditions, abandonment of unpaid transport, and a decrease of assembly pieces dedicated for transport. As a result, the Slovak Power Plants company decided to construct long period spent fuel storage. Wet storage is used in this operation and its capacity is 600 tHM (5,040 pieces of fuel assemblies).

The main reason for changing the original strategy of high level waste and spent fuel management was the abandonment of unpaid spent fuel transport after the political changes in the Russia Federation. With respect to the present economic situation in the Slovak Republic, it is impossible to decide on a new strategy in this field. Therefore, the Slovak Power Plants company decided to solve the problem with interim storage of spent fuel for approximately 50 years and start preparation of deep geological disposal of high level wastes and spent fuel under the conditions of the Slovak Republic.

19.2 HISTORY OF PROJECT DEVELOPMENT

The history of repository development designed to accept high level and long lived radioactive wastes and spent fuel started two decades ago. At that time the Nuclear Research Institute Rez (Czech Republic) issued some basic policies concerning the conceptual and safety aspects of a deep geological repository.

The year 1984 became a turning point for the intensification of activities towards underground facilities. Initiated by Energoproject with participation of Gasproject, and Construction Geology, the Nuclear Research Institute and other companies examined the possibility of constructing a deep silo (over 500 m) for reactor waste from NPP Dukovany and later NPP Temelin. Even though the project was abandoned, it provided valuable experience from the fields of geology, safety studies and contacts with the public.

Further activities, stimulated mainly by the need for processing waste arising from the decommissioning of NPP A-1 in Jaslovske Bohunice, were more precisely defined. They sought tools usable for evaluating the acceptability of sites, the solicitation of proper regions on the basis of archival data, and the extension of possibilities to provide safety analysis. The leading companies performing these activities were Geoindustry, Central Institute of Geology, Institute of Geophysics, Nuclear Research Institute, Nuclear Power Plant Research Institute, Dionyz Stur Geological Institute and others. One of the achievements reached was a basic evaluation of the Slovak territory for purposes of siting a deep geological repository.

It is reasonable that works aimed at the geological repository were performed by a number of institutions,

and their costs were covered from different sources. This led to a certain heterogeneity of activities and as a consequence an incongruity and incoherence in the results obtained. Therefore, urged by a need to initiate a program of spent fuel management, which arose after the political changes in Europe, the Federal Ministry of Economy of CSFR started the preparation of a technical program initiating the most urgent works in 1992. The purpose was to concentrate available agencies in a consistent, centrally coordinated contract. In the course of preparing this task, practically all central organizations involving contractors, as well as most research bodies active in waste management as suppliers, were involved. Firstly, the technical content of the project was defined and then, as a result of competition, the Nuclear Research Institute was appointed as coordinator. Unfortunately, due to the division of Czechoslovakia, funding of the project collapsed. To promote the primary purpose of the project, in the spring of 1993, the Czech Power Company and the Slovak Power Company decided to order a study on, "The plan for development of a deep geological repository" and to share its expenses equally.

In view of the importance of the report for further progress in repository development in the future, it was decided that the contractor should ensure an international review of the prepared document. For this purpose, a contact was established with the administration of The Nuclear Cycle Division of the International Atomic Energy Agency, which advised that the government ask for an evaluation within the Waste Management Assessment and Technical Review Program (WATRP). The results of the mission were attached to this study as a separate document in December 1993.

After the division of CSFR, work on development of deep disposal of high level wastes and spent fuel in Slovak Republic started only at the end of 1995. Because of the developments since 1993 in world-wide experience with deep disposal, and because the original project was elaborated for conditions in the former CSFR, the first step in continuing the work was the need to revise the original project for deep disposal development and adapt it to conditions in Slovakia.

19.3 PURPOSE OF PROJECT

The main goal of the revision was to specify the main bounds among the particular tasks of deep disposal development. This means taking into account all requirements for site selection, near-field and far-field interactions, quality assurance, safety analyses, the role of the public as well as design studies and licensing steps under the conditions of the Slovak Republic. The requirement of the customer was to compile a basic overview of activities aimed at the construction of a deep repository designed for spent fuel and for long lived and high level wastes. Especially, the research, development and design phases were to be thoroughly elaborated so that connections within each topic as well as between different problems are respected.

The technical characteristics of solutions for each topic had to be completed with consideration for time and economy; however, there are some doubts about the reliability of both tasks. The reason is simple. Development of the deep repository needs a very long time (tens of years), and thus, it is possible to make only extremely rough estimates of the time demands, and as a consequence, the economical needs of particular tasks. Furthermore, the time consumption is often dependent on non-technical issues, such as: the influence of public acceptability of particular solutions, licensing period, changes in development procedures due to political decisions, probability of receiving unacceptable results following the repetition of a certain volume of work, consequences of changes in legislation, etc.

The next requirement of the customer was to postulate in detail a 5-year program of work respecting the programs in progress, underlining within each topic the main activities that could, when postponed, retard solution of other development problems, and initiating new key tasks that have not yet been started.

The document, which is the result of the deep disposal project revision, will serve as a guide for all necessary research and development procedures that must be coordinated, and completely and equably answered in all aspects.

19.4 RESULTS OF PROJECT REVISION

To reach all claims during a very short period, the following procedure has been adopted:

- a philosophy of the study was selected that consists in parallel solutions of particular tasks by working groups supervised by an institution and a specialist experienced in waste disposal;
- some comprehensive problems were defined and

supervisors for each of them were nominated;
- nearly every three weeks, coordination meetings were organized in which the progress and results obtained were evaluated and critiqued, and goals for the next period were set up; and
- the final versions of the respective parts were compiled in this document and completed by introductory chapters and annexes.

The above mentioned procedure resulted in a structure of the document which describes a gradual improvement in each problem in connection with new developments in the field of deep disposal as well as their adaption to conditions in the Slovak republic. It is clear mainly when inspecting the diagrams. The diagrams are complemented by commentary that should explain the content of each of the activities. Its other role is to mention problems that could not be easily read from a diagram. The description of each particular task contains discussion about the economical and time aspects for the solution of the topic.

The detailed 5-year plan of activities describes the solution for each particular task in the development of spent fuel and deep disposal of high level waste until the year 2000. The plan contains concrete data on time and economy that are necessary for the deep disposal project realization. The main aim of the short-term plan is to show waste producers, as well as contractors of revisions, an extent, a content and a cost of anticipated works for the preparation of the deep repository construction. In this way, the plan can serve as a background document for planning purposes.

The basic result of the project revision, in which the solution of the whole project is shown, is a "Diagram of deep repository development" (Fig.19.1). This diagram is vertically divided into the main particular tasks, following the text of this report. Horizontal divisions indicate a time succession of activities in each topic and, to a certain level, it also parallels the implementation of the main works. It should be mentioned that the diagram is significantly simplified and that the time axis is not linear, which means that there is no correspondence with real timing of the topics being considered .

The diagram shows one interesting point. Practically every particular task, such as research and development, consists of several phases. They include construction, operation and closure of a facility, and they even include some data on the course of a final evaluation of safety and reliability of the system. When considering that this concerns a time period of more than one hundred years, then the role of a coordinator of all activities, credible working groups, and uncompromising control, supervision and licensing bodies must be stressed.

The main branch of the diagram is connected to a topic "Design activities and construction". This line comprises all principal decision processes. It also includes the key outcomes, design studies and designs, and construction procedures. It can be stated that the other main particular tasks provide the necessary data for decisions of a designer concerning the final solution of an underground repository and auxiliary facilities.

Geological works are connected to an evaluation of the mobility of contaminants in the geological system (far field interactions). Activities contained in this double-topic are focused on selection and verification of the suitability of a site and corresponding geological system for construction of a repository. They also summarize input data for safety analyses of long term behavior of the system.

Studies of the behavior of engineered barriers, final waste forms, packages, overpacks, sealing and filling materials, and underground constructions (near field interactions) are aimed at a choice of an optimum composition of barriers and to evaluate the effectiveness of their retention ability for radiocontaminants. Other species of disposed materials are to be evaluated as well (source term). The results of these studies provide proposals for material composition of repository construction addressed to designers, and data dealing with velocity, mechanisms, and probability of release of immobilized species.

The task of safety analyses is to summarize and evaluate all data received in the course of geological investigation and research, during construction and operation of a facility, at waste treatment processes. In addition, they lay down limits and conditions that any construction structure shall fulfill. Elaboration of safety analysis is the necessary condition for any licensing procedure, and thus, it can be considered to be the absolute key topic of repository achievement.

Quality assurance belongs to a group of activities designed to secure the maximum level of biosphere preservation. Its aim is to work out programs of control and supervision of all activities connected with reposi-

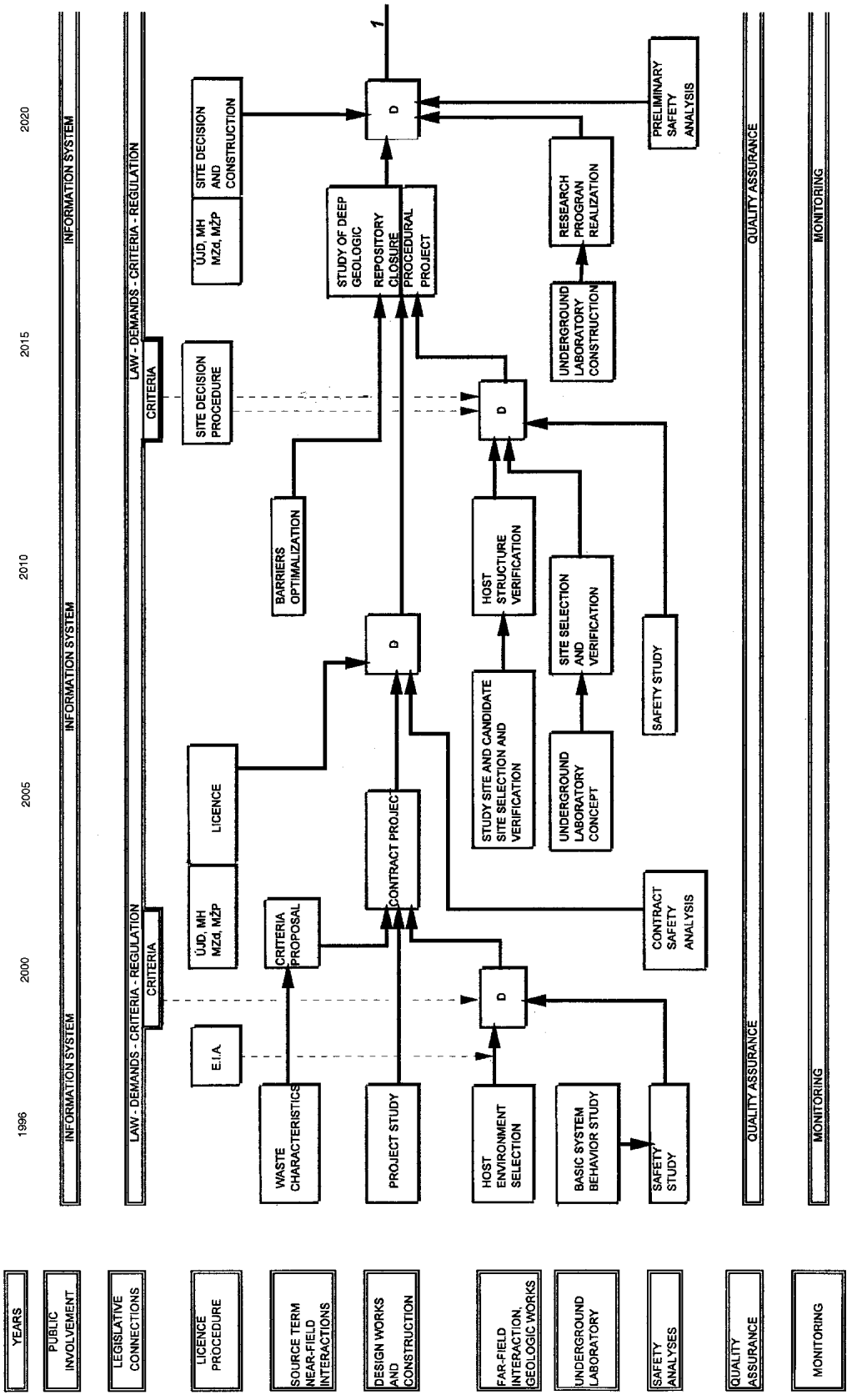

Figure 19.1a. Diagram of repository development.

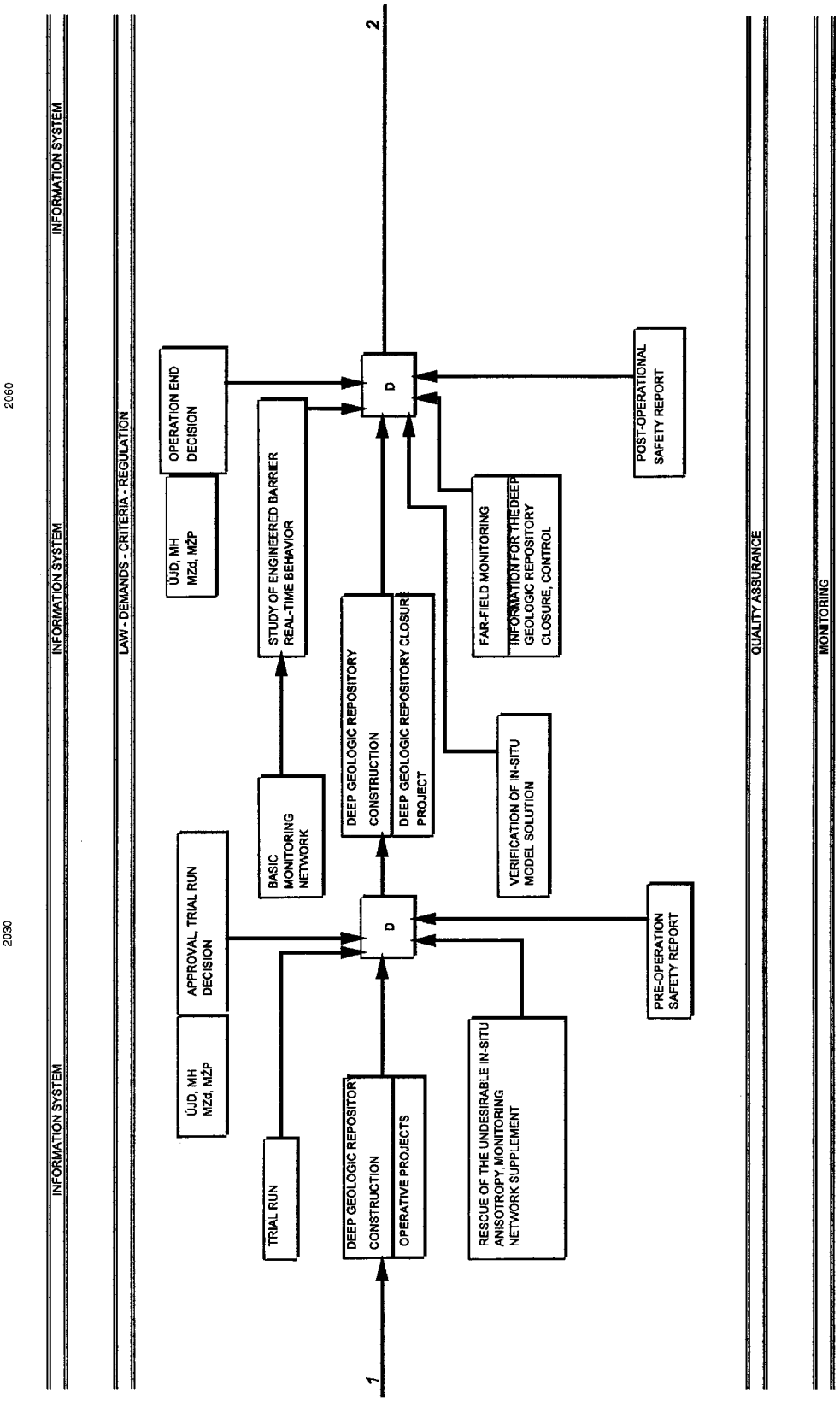

Figure 19.1b. Diagram of repository development (continued).

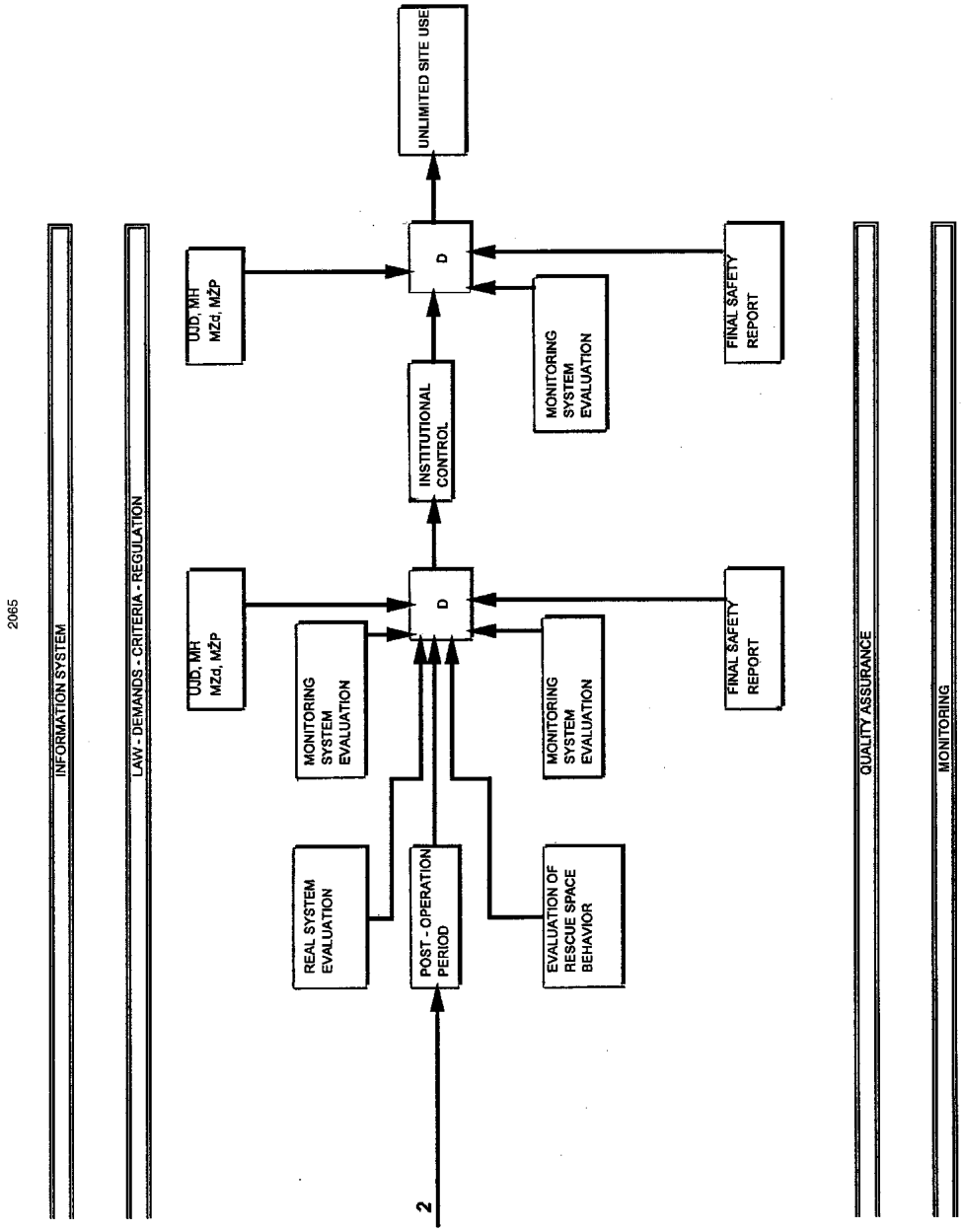

Figure 19.1c. Diagram of repository development (continued).

tory development and construction. The goal of these procedures is to eliminate risks mainly connected with the so called “human factor”.

The licensing processes are included in the particular task "legislation connections" because these processes influence significantly all other steps of deep disposal development. They permit each subsequent activity; they may on the basis of some independent evaluation prevent the implementation of such steps. Actually, they are connected to the formulation of claims, requirements, and methods. Sometimes they even set the conditions, and the licensing decisions are issued using an interpretation of these limits and recommendations for a concrete system.

Monitoring in the diagram (Fig.19.1) is considered to be an independent, permanently valid particular task, although in the study, it is described in other particular tasks. Deep disposal monitoring includes a number of steps: radiochemical, hydrological and hydrogeological monitoring of sites from the beginning of research; geological monitoring of a rock structure; measuring the radiological impacts to personnel and the public; recording the changes of state and behavior of barrier materials; meteorological records; observation of destructive and corrosion phenomena, etc. Interpretation of the monitored data is one of the basic conditions required for closure and release of the facility.

The results of particular tasks of the public may by its consequences not only influence but completely change any technical decision. Public involvement in the process of developing a deep repository has at least two aspects. First, passive, which is interpreted as an information campaign about the repository system, design, construction, safety, risks and advantages of its realization. Second, active, which is an effect of public meaning and also the design of the repository by independent opinions and evaluations. A first-rate program on communication with the public may simplify the achievement of the repository; on the contrary ignoring the necessity of reaching a concensus with the general public can completely eliminate the project.

The revised document for a project of deep disposal development is seen first of all as a methodological document. Particular problems of the project may differ in their content, but the approach to their solution has some common features, such as long-term considerations and the principle of conservatism.

The general feature of systems of radioactive waste management is the long-term consideration of all processes, activities and applicable phenomena. This is shown by the fact that partial issues are converted into material outputs after a long period, often reaching tens of years. Time factors bring a number of questions to an evaluation of the behavior of repository elements. To answer them requires finding unusual and substitute ways, e.g. mathematical modeling, studies of natural or man-made analogues.

An indirect interpretation used for waste form behavior during disposal is rather lengthy, and it involves some uncertainty. To reach a desired level of safety and functionality of the system, a principle of conservatism is applied in any evaluations. This means that those phenomena, or some combination, are considered that bring less favorable results.

The important fact in the methodology of deep disposal development is to have an objective approach to any step, activity or decision. That kind of solution is provided by preparation and realization of quality assurance programs. The main part of those programs is multiple opinions and evaluations of solutions. There is a tendency to leave out this demand. This is dangerous from two points of view. Any incorrect decision may cause irreparable damages even resulting in canceling the previous results, or the process of repository development may be suspended by a qualified opposition because of the inability technically to defend chosen solutions.

19.5 CONCLUSION

The revision of this project is the result of the work of a group of employees of the following institutions: DECOM Slovakia Ltd., Nuclear Power Plant Research Institute, Geologic office of Slovak Republic and EPG Invest Ltd. It has been worked out under the technical and editorial coordination of the DECOM Slovakia Ltd., however, separate authors are responsible for their own sections. All of those involved have attempted to develop an approach in the most objective way.

The goal of the activities was to perform a revision of the project from the year 1993, in which must be included the deep disposal development of the former Czechoslovakia, to incorporate the new world results of this field development, to modify it for conditions of Slovakia, and to add the economic and time considerations

to the technical solution. The determination of concrete activities through the year 2000 was an inseparable part of this methodological document. Each particular task of the project contains ideas about concrete activities, financial costs and solutions as well.

A summary of the above mentioned data in one document creates the material, which defines concrete activities and the needs of finance to assure the required output from a solution for a deep repository development under the conditions of Slovakia.